



OFFICE OF

BUILDING TECHNOLOGY,

STATE AND COMMUNITY PROGRAMS

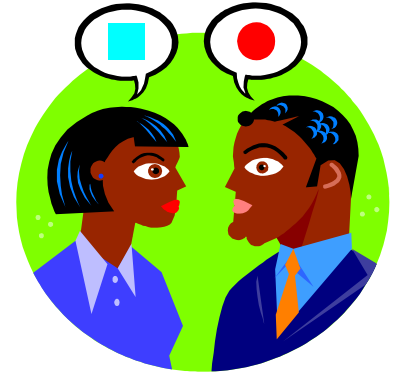
ANSI/ASHRAE/IESNA Standard 90.1-1999

Presented to the 2001 National Workshop
on State Building Energy Codes
by Mark Halverson, PNNL

Why is it important?

- ANSI/ASHRAE/IESNA Standard 90.1-1999 replaces ANSI/ASHRAE/IESNA Standard 90.1-1989 and the codified version of Standard 90.1-1989 (the gray book)
- Standard 90.1-1999 is the reference standard for Chapter 7 of the 2001 IECC
- Standard 90.1-1999 is also the commercial energy reference in NFPA's family of codes

How is it different?



- Standard was written in mandatory, enforceable language
- Standard contains true prescriptive path for envelope
- Mechanical and envelope sections heavily dependent on economic analysis
- Lighting section heavily dependent on lighting quality considerations
- Does pay considerable more attention to existing buildings

How is it different?

- Does not include lighting tradeoff software (LTGSTD)
- Does include a simplified mechanical systems approach for “simple” buildings
- Does include separate envelope requirements for non-residential, residential, and semi-heated spaces
- Is accompanied by ASHRAE Guideline 18 (ways to go beyond Standard 90.1)

How is it the same?

- Still contains separate envelope, HVAC, SWH, and lighting provisions
- Still includes envelope tradeoff software (ENVSTD)
- Still contains an energy cost budget tradeoff method



How have requirements changed?

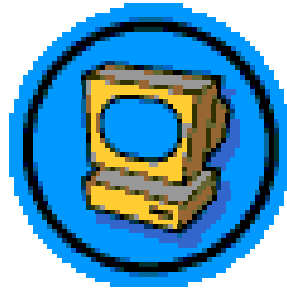
- Mechanical requirements generally more stringent (with exception of economizers)
- Envelope requirements a mixed bag – some more stringent, some less, depending on economics
- Lighting requirements generally more stringent with exception of some building types and space types

How can I find out more about the differences?

- Excruciatingly detailed comparisons of Standards 90.1-1989 and 90.1-1999 may be found at http://www.eren.doe.gov/buildings/codes_standards/buildings/com_determinations.html
- PNNL is also working on comparisons of the 90.1-1999 Standard and Chapter 8 of the 2001 IECC

How can I get a copy?

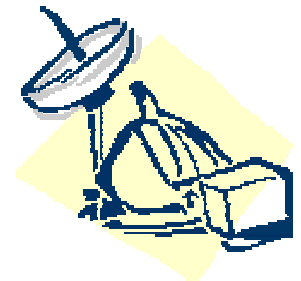
- Standard 90.1-1999, the Standard 90.1-1999 Users Manual, and the ENVSTD software are available from ASHRAE on the web at www.ashrae.org or by phone at 404-636-8400



How can I get more training?



- ASHRAE will be offering a Professional Development Seminar on Standard 90.1-1999. Contact ASHRAE for more info.
- A joint ASHRAE/DOE satellite broadcast on Standard 90.1-1999 is planned for October 30, 2001. See the BSGP web site for more info -



www.eren.doe.gov/buildings/codes_standards/buildings/

Standard 90.1-1999

Purpose (Section 1)

Scope (Section 2)

Definitions, Abbreviations, and Acronyms (Section 3)

Administration and Enforcement (Section 4)

Building Envelope (Section 5)

Heating, Ventilating, and Air-Conditioning (Section 6)

Service Water Heating (Section 7)

Power (Section 8)

Standard 90.1-1999

Lighting (Section 9)

Other Equipment (Section 10)

Energy Cost Budget Method (Section 11)

Normative References (Section 12)

4 appendices (mostly envelope related)
(Appendices A-D)

Informative References (Appendix E)

Section 1 - Purpose

The purpose of this standard is to provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings

Section 2 - Scope

- New buildings and their systems
- New portions of buildings and their systems
- New systems and equipment in existing buildings
- Envelope – only if heated above 3.4 btu/h-ft² or cooled above 5 btu/h-ft²
- Virtually all mechanical and lighting systems are covered

Scope Exceptions

- Too little heating or cooling equipment
- Single-family, multifamily of three stories or less, manufactured or modular homes
- Buildings that don't use electricity or fossil fuel
- Equipment and portions of building systems that use energy primarily for industrial, manufacturing, or commercial purposes

Section 3 - Definitions, Abbreviations, and Acronyms

- 10.5 pages of definitions
- 1 page of abbreviations and acronyms
- Defined terms are italicized in text of standard

Section 4 – Administration and Enforcement

- Specifies what applies to new buildings, existing buildings, additions to existing buildings, alterations to existing buildings
- Specifies exemptions for envelope, HVAC, SWH, power, lighting, and other equipment alterations
- Discusses changes in space conditioning

Section 4 – Administration and Enforcement

- Addresses compliance documentation
- Addresses labeling of materials and equipment
- Addresses alternative materials and methods of construction
- Addresses inspections

Section 5 – Building Envelope

- General 5.1
 - Scope
 - Compliance
 - Climate
 - Space-Conditioning Categories and Basis
- Mandatory Provisions 5.2
 - Insulation
 - Fenestration and Doors
 - Air Leakage
- Prescriptive Building Envelope Option 5.3
 - Opaque Areas
 - Fenestration
- Building Envelope Trade-Off Options 5.4

Scope

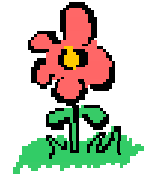
(Section 5.1.1)



- Envelope components that enclose
 - Conditioned space
 - Semi-heated space
 - Has a heating system with a capacity $> 3.4 \text{ Btu/h.ft}^2$ (10 W/m^2) of floor area but smaller than that needed to qualify for conditioned space
- Requirements apply to three types of spaces
 - Nonresidential
 - Residential
 - Semi-heated

Climate

(Section 5.1.3)



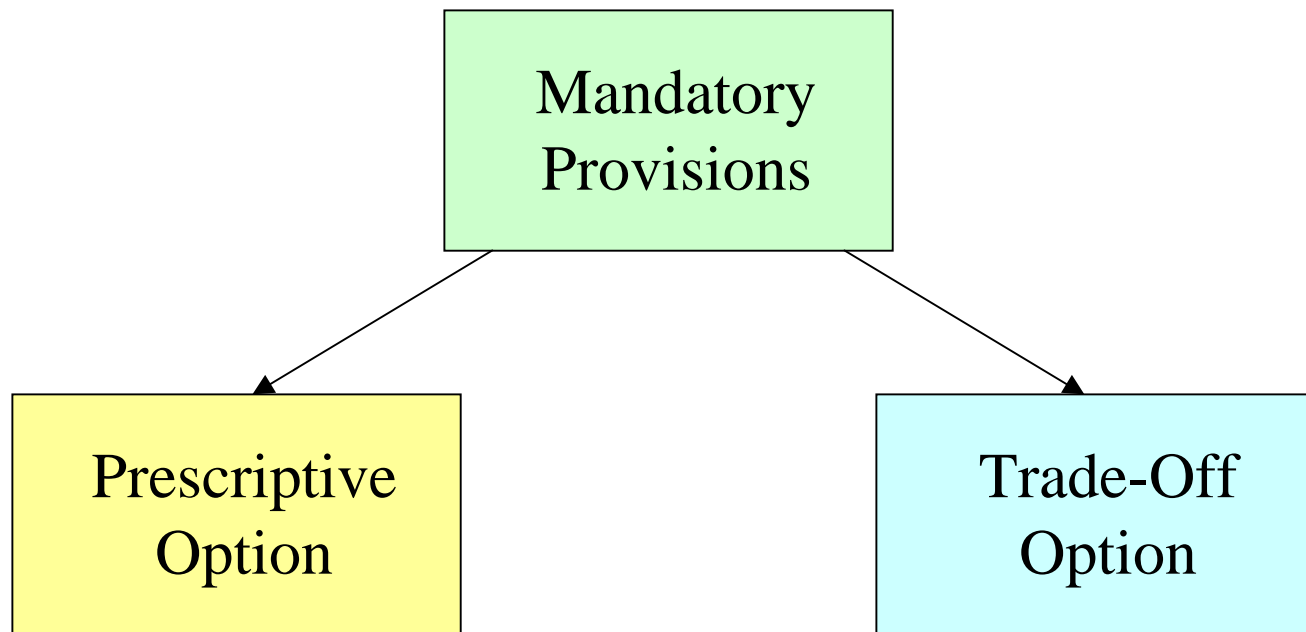
- Based on CDD50 and HDD65
 - Locations listed in Appendix D
 - If location not listed, select one with “closest” climatic conditions

Space-Conditioning Categories and Basis (Section 5.1.4)

- Each space to be included in a category
 - Nonresidential conditioned space
 - Residential conditioned space
 - Both nonresidential and residential semiheated space
- Spaces in climates > 1800 HDD65 assumed to be conditioned space unless
 - Space will be semiheated and is approved as such by building official
 - Space will be unconditioned and is approved as such by building official

Compliance Methods

(Section 5.1.2)



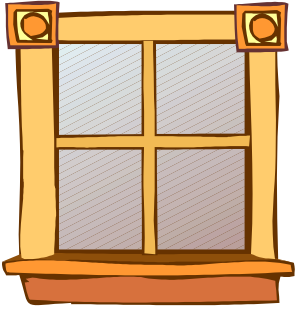
Mandatory Provisions

(Section 5.2)



- Insulation (5.2.1)
 - Installed per manufacturer's recommendations
 - Installed permanently and in substantial contact with inside surface of construction assembly
 - Recessed equipment doesn't reduce insulation thickness
 - No insulation directly over suspended ceilings with removable ceiling panels
 - Exterior insulation protected from damage

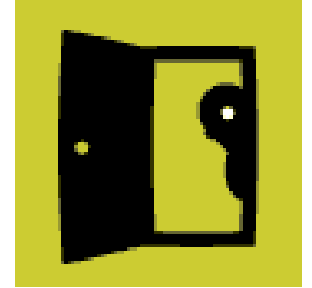




Mandatory Requirements

Fenestration and Doors

(Section 5.2.2)



- U-factors
 - NFRC 100 or
 - Assemblies listed in Appendix A
- SHGC
 - NFRC 200 or
 - Assemblies listed in Appendix A
- Visible Light Transmittance
 - NFRC 200 when trade-off option is used
 - *(No actual requirements for VLT)*

Mandatory Provisions

Air Leakage

(Section 5.2.3)



- Building envelope should be sealed
- Fenestration and doors should be tested and tight
- Loading dock weatherseals should be used in cold climates
- Vestibules are required for many buildings

Building Envelope Prescriptive Option (Section 5.3)

WWR less than or equal to 50% of gross wall area
Skylight-roof ratio less than or equal to 5% of roof area
Each envelope component must separately meet requirements

- 26 criteria sets for different climate types
 - Set = single page that summarizes all prescriptive requirements
 - Insulation levels for roofs, walls floors
 - Fenestration criteria

Envelope Prescriptive Option

Opaque Areas

(Section 5.3.1)

- Compliance

- Meet or exceed minimum rated R-values in table

- Only R-value of insulation, not to include air films, etc

OR

- Meet maximum U-factor, C-factor, or F-factor for the entire assembly

OR

- Perform area-weighted average U-factor, C-factor, or F-factor

- Only if there are multiple assemblies within a single class₂₇ of construction for a single space-conditioning category

Envelope Prescriptive Option

Fenestration

(Section 5.3.2)

- Compliance
 - Meet or exceed maximum U-factors in table
 - Meet or exceed minimum SHGC in table
 - Use NFRC ratings or default values in Appendix A

Section 6 - HVAC Compliance

- Simplified Approach Option (6.1)
- Mandatory Provisions (6.2) + Prescriptive Path (6.3)
- Mandatory Provisions (6.2) + Energy Cost Budget (11)

HVAC Simplified Approach Option (Section 6.1)

- Limited to...
 - Buildings with 1 or 2 stories
 - Buildings less than 25,000ft²
 - Single-zone system
 - Air-cooled or evaporatively cooled only



Simplified (*cont'd*)

- Manual changeover or dual set-point thermostat
- Heat pump supplementary heat controls
- No reheat or simultaneous heating and cooling for humidity control
- Time clocks (except hotel/motel...)
- Pipe insulation
- Ductwork and plenum insulation
- Ducted system to be air balanced to within 10% of design air flow rates
- Interlocked thermostats to prevent simultaneous heating and cooling
- Exhaust dampers (design capacity > 300 cfm unless continuous operation)
- Optimum start controls (design supply air capacity $> 10,000$ cfm)

HVAC Mandatory Provisions (*Section 6.2*)

- Mechanical Equipment Efficiency (6.2.1)
- Load Calculations (6.2.2)
- Controls (6.2.3)
- HVAC System Construction and Insulation (6.2.4)
- Completion Requirements (6.2.5)

Required in both Prescriptive and ECB
compliance paths

Equipment Covered for the First Time

- Ground-source heat pumps
- Single- and double-effect absorption chillers
- Heat rejection equipment
- New categories for
 - Hot water and steam boilers
 - Replacement PTACs and PTHPs

HVAC Mandatory Provisions

Completion Requirements (*Section 6.2.5*)

- Record drawings of actual installation to building owner within 90 days of system acceptance
- Operating and maintenance manuals within 90 days of system acceptance
- System Balancing with 10% of design

HVAC Prescriptive Path

(Section 6.3)

- Economizers 6.3.1
- Simultaneous Heating and Cooling Limitation 6.3.2
- Air System Design and Control 6.3.3
- Hydronic System Design and Control 6.3.4
- Heat Rejection Equipment 6.3.5
- Energy Recovery 6.3.6
- Exhaust Hoods 6.3.7
- Radiant Heating Systems 6.3.8
- Hot Gas Bypass Limitation 6.3.9

Prescriptive Path

Economizers

(Section 6.3.1)

- Table 6.3.1 lists requirements in terms of system size, Twb, and daily hours when air temp is appropriate
- There are LOTS of exceptions
- Can use air economizers
 - 100% of design supply air
 - Sequenced with mechanical cooling equipment
 - High limit shutoff
 - Dampers
- Can use water economizers
 - 100% of expected system cooling load
 - Maximum pressure drop

Prescriptive Path/Water Economizers

Integrated Economizer Control

(Section 6.3.1.3)

- Economizers must be integrated with mechanical cooling systems and be capable of providing partial cooling even when additional mechanical cooling is required
- Some exceptions to this

Prescriptive Path/Water Economizers
Economizer Heating System Impact
(Section 6.3.1.4)

- Designed so economizer operation doesn't increase the building heating energy use during normal operation
- Exception
 - Where heating is allowed by 6.3.2

Prescriptive Path

Simultaneous Heating and Cooling Limitation (*Section 6.3.2*)

- Zone controls capable of operating in sequence the supply of heating and cooling energy to the zone to prevent reheating, recooling, mixing or simultaneously supplying air previously heated or cooled
- Hydronic system controls to prevent reheating or recooling of fluids

Prescriptive Path

Simultaneous Heating and Cooling Limitation (*Section 6.3.2*)

- Dehumidification controls for humidistats to prevent reheating, mixing, etc
- Humidification controls

Prescriptive Path

Air System Design and Control

(Section 6.3.3)

- HVAC systems with total fan system power > 5 hp
 - Fan Power Limitation
 - VAV Fan Control
 - Part Load Fan Power Limitation
 - Static Pressure Sensor location
 - Set Point Reset

Prescriptive Path

Hydronic System Design and Control

(Section 6.3.4)

- HVAC hydronic systems with total pump system power > 10 hp
 - Hydronic Variable Flow Systems
 - Pump Isolation
 - Chilled and Hot Water Temperature Reset

Prescriptive Path
Heat Rejection Equipment
(Section 6.3.5)

- Applies to heat rejection equipment used in comfort cooling systems such as
 - Air-cooled condensers
 - Open cooling towers
 - Closed-circuit cooling towers
 - Evaporative condensers
- Exceptions
 - Heat rejection devices included as an integral part of equipment listed in Tables 6.2.1A-6.2.1D

Prescriptive Path

Fan Speed Control

(Section 6.3.5.2)

- Each fan powered by a motor greater than or equal to 7.5 hp
 - Have capability to operate fan at less than or equal to 2/3 full speed
 - Have controls to automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device
- Exceptions
 - Condenser fans serving multiple refrigerant circuits or flooded condensers
 - Installations located in climates greater than 7500 CDD50
 - less than or equal to 1/3 of fans on a condenser or tower with multiple fans, where the lead fans comply with the speed control requirement

Prescriptive Path
Energy Recovery
(Section 6.3.6)

- Exhaust Air Heat Recovery
 - Lots of exceptions
- Service Water Heating Heat Recovery
 - Lots of conditions and exceptions

Prescriptive Path
Exhaust Hoods
(Section 6.3.7)

- Kitchen hood makeup air
- Fume hood VAV or makeup air or heat recovery

Prescriptive Path

Radiant Heating Systems

(Section 6.3.8)

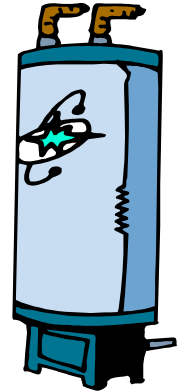
- If heating is required for unenclosed spaces, use radiant heating
 - Exception - Loading docks equipped with air curtains
- Radiant heating used in enclosed spaces must comply with the governing provisions of the standard.

Prescriptive Path
Hot Gas Bypass Limitation
(Section 6.3.9)

- Not used (including other evaporator pressure control systems) unless system is designed with multiple steps of unloading or continuous capacity modulation
- Exception
 - Unitary packaged systems with cooling capacities less than or equal to 90,000 Btu/h

Section 7 - Service Water Heating

- General 7.1
- Mandatory Provisions 7.2
 - Sizing of systems
 - Equipment efficiency
 - Service hot water piping insulation
 - System controls
 - Pools
 - Heat traps
 - Space heating and water heating
 - Service water heating equipment
- Prescriptive Path 7.3



Service Water Heating
Compliance
(Section 7.1.2)

- Mandatory + Prescriptive Path **OR**
- Mandatory + Energy Cost Budget

Mandatory Provisions

Sizing of Systems

(Section 7.2.1)

- In accordance with manufacturer's published sizing guidelines

Mandatory Provisions

Equipment Efficiency

(Section 7.2.2)

- Table 7.2.2
- Equipment not listed in Table 7.2.2 has no minimum performance requirements
- Exception
 - Water heaters and hot water supply boilers > 140 gal storage capacity don't have to meet standby loss requirements when
 - Tank surface is thermally insulated to R-12.5, and
 - A standing pilot light isn't installed, and
 - Gas- or oil-fired water heaters have a flue damper or fan-assisted combustion

Mandatory Provisions
Service Hot Water Piping Insulation
(Section 7.2.3)

- Table 6.2.4.5, Section 6
- Circulating water heater
 - Recirculating system piping, including supply and return piping
- Nonrecirculating storage system
 - First 8 ft of outlet piping
 - Inlet pipe between storage tank and heat trap
- Externally-heated pipes (heat trace or impedance heating)

Mandatory Provisions

System Controls

(Section 7.2.4)

- Temperature controls
- Temperature Maintenance Controls
- Outlet Temperature Controls
- Circulating Pump Controls

Mandatory Provisions
Pools
(*Section 7.2.5*)



- Pool heaters to have readily accessible on-off switch
- Pool heaters fired by natural gas to NOT have continuously burning pilot lights
- Pool covers required (unless recovered or solar heat)
- Time switches required



Mandatory Provisions
Heat Traps
(Section 7.2.6)

- Noncirculating systems to have heat traps on both the inlet and outlet piping as close as practical to storage tank (if no integral heat traps)
 - Either a device specifically designed for this purpose or
 - Arrangement of tubing that forms a loop of 360° or piping that form the point of connection to the water heater includes a length of piping directed downward before connection to the vertical piping of the supply water or hot water distribution system, as applicable

Prescriptive Path

Space Heating and Water Heating (Section 7.3.1)

- Gas- or oil-fired space heating boiler system (complying with Section 6) is allowed to provide total space heating and water heating when ONE of the following conditions is met
 - Single boiler or component that is heating the service water has a standby loss in Btu/h not exceeding
 - $(13.3 \times pmd + 400) / n$; where *pmd* is probable maximum demand in gal/h and *n* is the fraction of the year when outdoor daily mean temperature is greater than 64.9°F
 - Jurisdiction agrees use of a single heat source will consume less energy than separate units
 - Energy input of the combined boiler and water heater system is less than 150,000 Btu/h
- Instructions for determining standby loss are included in this Section

Service Water Heating/Prescriptive Path

Service Water Heating Equipment

(Section 7.3.2)

- Equipment used to provide the additional function of space heating as part of a combination (integrated) system shall satisfy all requirements for service water heating equipment

Section 8 - Power

- Voltage drop
- Completion requirements



Voltage Drop

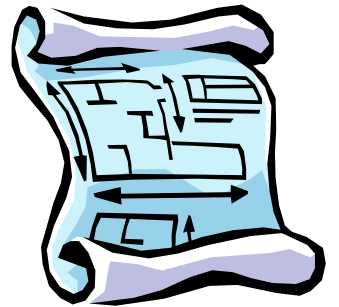
(Section 8.2.1)

- Two types of conductors
 - Feeder conductors
 - Run between the service entrance equipment and the branch circuit distribution equipment
 - 2% maximum voltage drop allowed
 - Branch circuit conductors
 - Run from the final circuit breaker to the outlet or load
 - 3% maximum voltage drop allowed

Completion Requirements

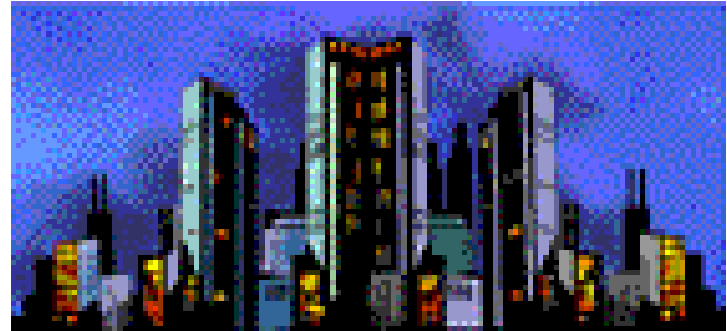
(Section 8.2.2)

- Owner gets information about the building's electrical system
 - Record drawings of actual installation within 30 days
 - Single-line diagram of electrical distribution system
 - Floor plans showing location of distribution equipment and areas served by equipment
 - Manuals
 - Submittal data stating equipment nameplate rating
 - O&M manuals for equipment
 - Qualified service agency
 - Complete narrative and schematic of system as it's normally intended to operate



Section 9 - Lighting

- General Application 9.1
- Mandatory Provisions 9.2
 - Lighting controls
 - Tandem wiring
 - Exit signs
 - Installed interior lighting power
 - Luminaire wattage
 - Exterior building grounds lighting
- Prescriptive Path 9.3
 - Interior Lighting Power Allowance
 - Building Area Method
 - Space-by-Space Method
 - Exterior Lighting Power Allowance



General Application

- Interior spaces of buildings
- Exterior building features
- Exterior grounds lighting powered through building
- Exceptions
 - Emergency lighting
 - Lighting required by life safety statute
 - Lighting within living units of buildings
 - Decorative gas lighting

Lighting Changes Between 90.1-1989 and 90.1-1999

- More efficient lighting
 - Less power allowed
- No lighting control credits
 - Lighting power allowance now based only on connected lighting power
- No control points for spaces
- No separate lighting controls for daylighted spaces

Lighting Changes Between 90.1-1989 and 90.1-1999 *(cont'd)*

- Automatic shutoff controls required
- Most exterior power requirements replaced with minimum efficacy requirements
 - Parking garages included in interior lighting
- Interior power requirements updated
 - More stringent requirements
 - Area factors no longer need to be calculated
 - Building area allowances no longer depend on size

Lighting Scope

- New construction
 - Nonresidential
 - High-rise residential
- Existing nonresidential and high-rise residential
 - If greater than or equal to 50% of existing luminaires are replaced
 - If renovation increases lighting power
- Control devices can't control
 - Greater than 2500 ft² in spaces less than 10,000 ft²
 - Greater than 10,000 ft² in spaces greater than 10,000 ft²
- Control must be readily accessible and located so occupants can see the controlled lighting

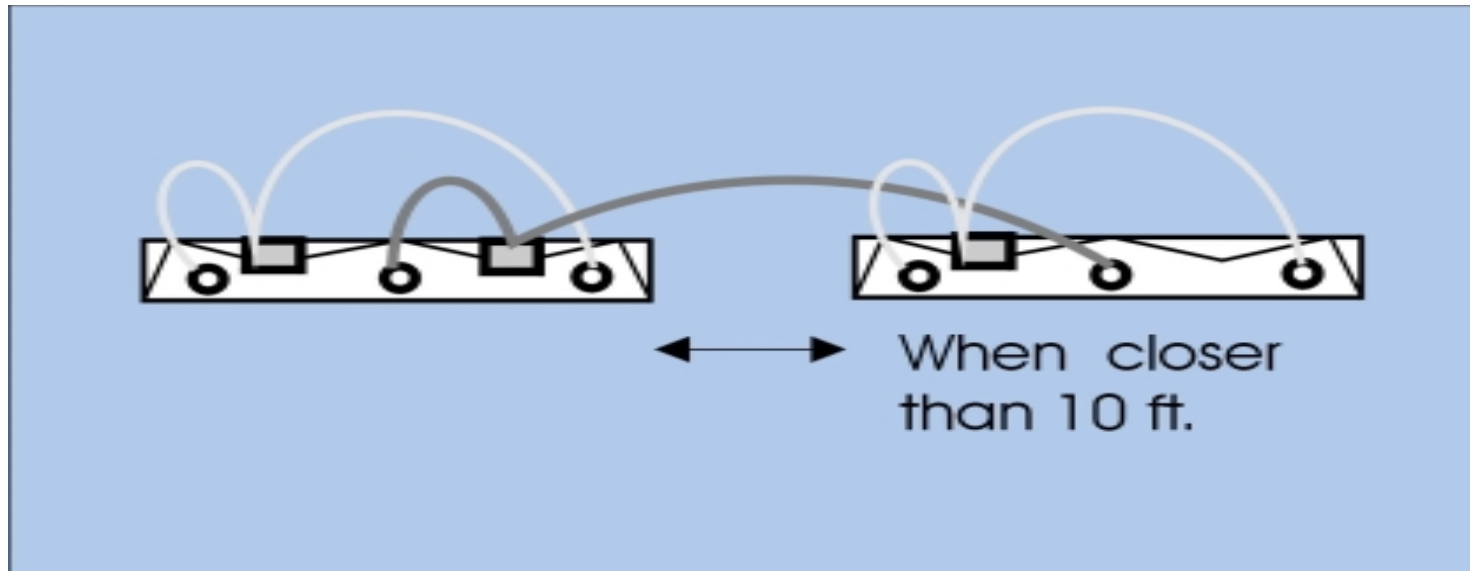
Mandatory Provisions
Lighting Control
(Section 9.2.1)

- Automatic lighting shutoff
 - Applies to buildings $> 5000 \text{ ft}^2$
- Space Control
 - At least one readily accessible control
- Exterior lighting control
- Additional controls for specialty lighting such as task, case, display, plant lighting.

Mandatory Provisions

Tandem Wiring

(Section 9.2.2)



Mandatory Provisions Tandem Wiring Exceptions

- Separated surface or pendant luminaires
- Recessed luminaires more than 10 ft apart
- Other luminaires
 - With three-lamp ballasts
 - On emergency lighting circuits
 - With no available pair
 - With one lamp, high frequency, electronic ballast

Mandatory Provisions

Exit Signs

(Section 9.2.3)



- Exit signs operating at > 20 W must have a source efficacy greater than or equal to 35 lumens/W
- LED lamps okay
- CF lamps with electronic ballasts usually okay
- Majority of incandescent lamps not okay

Mandatory Provisions

Installed Interior Lighting Power (*Section 9.2.4*)

- Includes all permanent and portable interior lighting intended for general, ambient, or task illumination
- Includes lamp, power used by ballast, the control (when applicable), current regulators, and any other power draws associated with the lighting system
- Exception
 - If 2 or more independently operating lighting systems in a space can be controlled to prevent simultaneous operation, can base IILP on lighting system with highest wattage

Mandatory Provisions
Luminaire Wattage
(Section 9.2.5)

- Standard incandescent = max. labeled wattage of the luminaire
- Luminaires with ballasts = wattage of the lamp/ballast combination
- Line voltage track = min. 30 W per foot
- Low voltage track = transformer wattage
- All others as specified



Mandatory Provisions
Exterior Building Grounds Lighting
(Section 9.2.6)

- Luminaires that operate at $> 100 \text{ W}$ = efficacy $> 60 \text{ lumens/W}$
- Exceptions
 - Traffic signals
 - Lighting within outdoor signs
 - Lighting used to illuminate public monuments or registered historic landmarks
 - If an occupancy sensor or motion sensor controls the lighting application

Lighting Prescriptive Path Interior Lighting Power

- Lots of exemptions
- Calculation methods
 - Building area
 - Space-by-space
 - Trade-offs of interior lighting power allowance among portions of the building for which a different calculation method has been used is not permitted

Lighting Power Allowance Exemptions

- Theatrical, stage, film, and video production
- Medical and dental procedures
- Exhibit displays for museums monuments, and galleries
- Plant growth or maintenance
- Integral to equipment or instrumentation installed by manufacturer
- Integral to both open and glass-enclosed refrigerator and freezer cases
- Retail display windows, provided the display is enclosed by ceiling-height partitions
- Interior spaces specifically designated as registered interior historic landmarks
- Integral part of advertising or directional signage
- Exit signs
- Sale or lighting educational demonstration systems
- Athletic playing areas with permanent facilities for TV broadcasting
- Casino gaming areas
- For use in areas specifically designed for the visually impaired

Lighting Prescriptive Path
Building Area Method
(Section 9.3.1.1)

- Used for projects involving
 - An entire building
 - A single, independent, and separate occupancy in a multi-occupancy building
- Gross lighted area is multiplied by allowance from Table 9.3.1.1
- Limitations
 - Insensitive to specific space functions and room configurations
 - Generally is more restrictive
 - Does not apply to all building types - but “selection of a reasonably equivalent type” is permitted

Lighting Prescriptive Path

Gross Lighted Area

- Sum of total lighted area of a building
 - Measured from the exterior faces of the exterior walls or from the centerline of walls separating buildings
- Used in the building area method of determining interior lighting power allowance

Lighting Prescriptive Path
Space-by-Space Method
(Section 9.3.1.2)

- $LPA = A \times LPD$
 - A = floor area of space
 - LPD = lighting power density from Table 9.3.1.2
- $ILPA$ = sum of LPA for each space
- Advantages
 - More flexible
 - Applicable to all building types
 - Accounts for room geometry

Lighting Prescriptive Path

Additional Interior Lighting Power

- An increase in the ILPA is allowed for specific space functions when using the space-by-space method
 - Decorative – 1.0 W/ft² in space used
 - Fluorescent designed to eliminate glare
 - Accent lighting in specific space used
 - Additional 1.6 W/ft², or
 - Additional 3.9 W/ft² for fine merchandise

Lighting Prescriptive Path

Exterior Building Lighting Power (*Section 9.3.2*)

- Sum of all lighting power allowances for applicable exterior applications
- Building Surface Requirements
 - Building entrance with canopy – 3 W/ft²
 - Building entrance – 33 W/linear ft
 - Building exit – 20 W/linear ft
 - Building facades – 0.25 W/ft²
- Exceptions, when equipped with a control device
 - Specialized signal, directional, and market lighting associated with transportation
 - Public monuments
 - Registered historic landmark structures or buildings
 - Lighting integral to advertising signage

Section 10 - Other Equipment

- Changes between 90.1-1989 and 90.1-1999
 - No transformer recommendations and requirements
 - No subdivision of electrical feeders or provisions for check metering
 - Motor efficiency levels are higher and correspond to EPA Act
 - Motor efficiency requirement now covers all relevant motors, even if they're part of equipment rated elsewhere in the Standard
 - No exemption for motors running less than 1000 hrs/yr

Section 11 - Energy Cost Budget Method

- The ultimate trade-off method allowing you to trade-off across building systems through the use of annual, hourly simulation tools and a baseline building.
- The only real way to deal with unique designs, renewables, high-efficiency equipment, etc.
- The basis of the energy portion of the LEED rating
- See *COMcheck-Plus* for an ECB program



Section 12 - Normative References

- Normative (read “mandatory”) reference documents
- Includes test methods, rating procedures, and other standards

Assembly U-Factor, C-Factor, and F-Factor Determination (Normative Appendix A)

- A whole series of pre-calculated performance factors for a wide range of building envelope assemblies
- 26 different reference tables ranging from the default u-factors for windows and skylights to the thermal conductivity of concrete blocks

Building Envelope Criteria

(Normative Appendix B)

- Actual prescriptive requirements tables for 26 different climate bins
- These are in an appendix because they would have taken up too much space in Chapter 5 and would have broken up the continuity of the text of the Standard

Methodology for Building Envelope Trade-Off Option in Subsection 5.4 (Normative Appendix C)

- The gory details of how the envelope trade-off option is implemented
- For those familiar with the “old” ENVSTD trade-off, this new trade-off allows trade-offs between roof and wall elements. The “metric” of trade-off is ultimately an energy dollar trade-off.

Climate Data

(Normative Appendix D)

- Climatic data for a number of US, Canadian, and international locations
- HDD65 and CDD50 for use in envelope calculations
- Heating and cooling design temperatures and the old “number of hours between 8 am and 4 pm with Tdb between 55 and 69” for HVAC calculations

Informative References

(Informative Appendix E)

- Other useful references that are not mandatory
- In general, these are not consensus documents so ASHRAE procedures do not allow them to be mandatory references